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Real Exchange Rate Volatility in Kenya

[1]Danson Musyoki, [2]Ganesh P. Pokhariyal and [1]Moses Pundo

[1]Department of Accounting and Finance, Catholic of Eastern Africa
[2]School of Mathematic, University of Nairobi; Kenya

Corresponding Authors: Danson Musyoki

Abstract

This paper examines Real Exchange Rate (RER) volatility in Kenya by using Generalized Autoregressive Condition of Heteroscedasticity (GARCH) and computation of the unconditional standard deviation of the changes for the period of January 1993 to December 2009. Data for the study was collected from Kenya National Bureau of Statistics, Central Bank of Kenya and International Monetary Fund Data Base by taking monthly frequency. Thus, 204 data values were analysed, which assisted in evaluating the extent of the trade Kenya had with different countries and used in the construction of the Real Exchange Rate (RER). The study found that RER was very volatility for the entire study period. Kenya's RER generally exhibited a appreciating and volatility trend, implying that in general, the country's international competitiveness deteriorated over the study period. The RER Volatility reflect negative effect on economic growth of Kenya.

Keywords: real exchange rate, nominal exchange rate, real effective exchange rate, nominal effective exchange rate, volatility, GARCH

INTRODUCTION

During the era of the fixed exchange rate regime, that covered the period of 1966-92, Kenya, like many developing countries, had to frequently devalue its currency in an attempt to reduce the negative effects that RER volatility had on its economy. The adoption of a floating exchange rate system in 1993 marked the climax of efforts to make the RER more aligned to the market determined equilibrium RER, and thus eliminate RER volatility. There is, however, no available evidence that success has since been achieved in realizing the objective for which the foreign exchange market was liberalized. Large volatilities in nominal exchange rates have since characterized Kenya financial market (Kiptoo 2007). The current study examines and maps out the profile of Kenya's RER volatility for the period January 1993 to December 2009. The real exchange rate (RER), defined as the rate at which goods, and services produced at home can be exchanged for those produced in another country or group of countries abroad, has been recognized as an important aspects in international macroeconomics, and finance. It can be expressed in nominal or real terms. It is referred to as the nominal exchange rate (NER) when inflation effects are embodied in the rate, and as the (RER) when inflation influences have been excluded (Copeland, 1989:4, Lothian, and Taylor, 1997). Volatility in the RER has important implications on Kenya's economic growth. Increased RER volatility would, for instance, increase the uncertainty of profits on contracts denominated in a foreign currency, and would therefore reduce economic growth to levels lower than would otherwise exist if uncertainty were removed (Cote, 1994). Various studies, particularly, in the developed and middle-income countries, have also explored the impact of exchange rate volatility and associated uncertainty on trade, investment, and economic growth. Majority of these studies have found that exchange rate volatility can affect trade directly, through uncertainty and adjustment costs, and indirectly through its effect on the structure of output and investment (Cote, 1994, Serven, 2002, Pickard, 2003, Cheong, 2004, Kikuchi 2004, Arize et al., 2004).

Real Exchange Rate Volatility

RER volatility refers to short-term fluctuations of the RER about their longer-term trends (Frenkel and Goldstein, 1989). It also entails short-term (monthly, weekly, or even hourly) fluctuations in the exchange rates as measured by, their absolute percentage changes during a particular period (Williamson, 1985). Excess RER volatility has been known to reduce the level of economic growth by creating uncertainty about the profits, unemployment, and poverty. It is also known to restrict the international flow of capital by reducing both direct investment in foreign operating facilities, and financial portfolio investment. Finally, increased RER volatility may lead to higher prices of internationally traded goods by causing traders to add a risk premium to cover unanticipated exchange rate fluctuations (McKinnon, and Ohno, 1997). There are two situations in which flexible exchange rates may be described as too volatile. First, exchange rates can be fully consistent with fundamental economic variables, such as relative prices, and macroeconomic policies, while still responding excessively to shocks to those variables before adjusting gradually to new long-term equilibrium levels. Such exchange rate 'overshooting' may occur because international capital markets adjust almost instantaneously to shocks, while goods and services markets adjust slowly (Dornbusch, 1976). While predictable, this type of exchange rate volatility is costly since it amplifies the domestic impact of disturbances arising in foreign markets, exacerbating fluctuations in domestic growth, and unemployment. Second, flexible exchange rates may be too volatile if they are primarily influenced by factors unrelated to fundamental economic variables. In this case, exchange rate movements would be largely unpredictable, especially, in the short term.

Exchange Rate Determination

Economists and financial experts are yet to agree on a single theory that defines the exchange rate. Hitherto, there are at least five competing theories of the exchange rate concept, which may either be classified as traditional or modern. The traditional theories are based on trade and financial flows, and purchasing power parity, and are important in explaining exchange rate movements in the long run. These theories are: the elasticity approach to exchange rate determination, the monetary approach to exchange rate determination, the portfolio balance approach to exchange rate determination, and the purchasing power theory of exchange rate determination. The modern theory, however, focuses on the importance of capital and international capital flows, and hence, explains the short run volatility of the exchange rates and their tendency to overshoot in the long run. The literature that focuses on the effects of RER volatility on trade, and investment in developing countries is not as substantial as it is for developed countries (Kiptoo 2007).

Overview of Kenya's Exchange Rate Policy

The exchange rate of Kenya shilling to the US Dollar from 1967 to 2009 has been described by the fixed exchange rate error, the crawling peg error and the floating error.

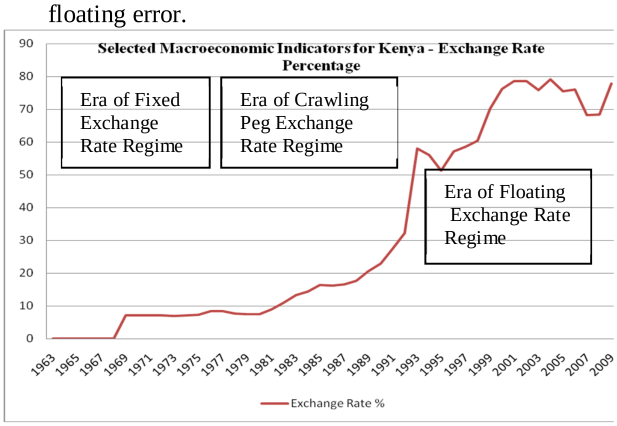

Figure 1.1 : Profile of Kenya's Exchange Rate Regimes, 1967-2009 (Kenya Shilling per US dollar)
Source: Derivations from data from Kenya National Bureau of Statistics (KNBS)-2010

The Model Estimation Methods

The real exchange rate *(rer)* is obtained by adjusting the nominal exchange rate (*ner*) with inflation differential between the domestic economy, and foreign trading partner economies. The derivation of the *rer* therefore, requires that the data of the *ner*, domestic inflation and foreign inflation be obtained. Since the Kenya shilling appreciated against some currencies and depreciated against others during the study period, the Nominal Effective Exchange Rate (*NEER*) is constructed. The *NEER* is derived by weighting the bilateral shilling exchange rate against its trading partner currencies using the value of Kenya's trade (imports plus exports) with its respective trading partners. The data required to derive the *NEER* is for Kenya's bilateral exchange rates with respective trading partners. Since some of the data on bilateral exchange rates are originally expressed in terms of (United States) US dollars, cross rates had to be obtained, so as to have all bilateral exchange rates expressed in terms of Kenya Shilling per foreign currency. The calculation of the *NEER* is achieved through the arithmetic mean approach that involves summing up the trade weighted bilateral exchange rates as shown in equation 1 below:

$$NEER_t = \sum_{it}^{n} ER_{it} * w_{it} \qquad (1),$$

where, ER_{it} is Kenya's bilateral exchange rate index with country i at time t while w_{it} is the bilateral trade weight for Kenya's i^{th} trading partner at time t. Each bilateral exchange rate index (ER_{it}) in equation 1 is computed as follows:

$$ER_{it} = \left[\frac{NER_c}{NER_{t=0}}\right] * 100 \qquad (2),$$

where, the NER_c is the index of Kenya shilling exchange rate per unit of trading partner currency in the base period (2007) while $NER_{t=0}$ is the index or Kenya shilling exchange rate per unit of trading partner currency in the current period year.

The choice of 2007 as the base year is rationalized in terms of relative stability of the economy, and low volatility in the domestic foreign exchange market during the year. Kenya's Gross Domestic Product (GDP) growth rate during this period was 7.1%, the highest rate ever achieved during the 1993-2009-study period. The year 2007 also enjoyed macroeconomic stability, with inflation rates that were not only low but also stable, while the current account balance as well as fiscal deficits was considered to have been at sustainable levels.

Each monthly bilateral trade weight in equation 1 was computed as a ratio of total trade (exports plus imports) for each trading partner to the ratio of total trade (export plus imports) for all Kenya's trading partners. The formula used in deriving the trade weights is:

$$w_{it} = \left[\frac{\sum(x_{it} + m_{it})}{\sum(X_t + M_t)}\right] \quad (3),$$

where, x_{it} is total value of Kenya's exports to i^{th} trading partner at time *t*, m_t is the total value of imports from Kenya's i^{th} trading partner also at time *t*, X_t are Kenya's total exports to all trading partners at time *t*, and M_t are total imports to all trading partners at time *t*. In this study *i=1, 2 .....,n* where *n* is the total number of Kenya's trading partners which in this study was 140. The *NEER* is obtained by combining equations 2, and 3 using the following formula:

$$NEER_t = \sum_{it}^{n} ER_t * w_t \quad (4),$$

where, ER_t is the bilateral exchange rate (equation 2), and w_t, is the bilateral trade weight, *n* is the total number of countries, which is 140. Based on (equation 4), a decline in *NEER* represents an appreciation, while an increase represent a depreciation of the *NEER*. This is because in the calculation of the *NEER* index, the base year (2007) exchange rate is taken as the denominator while the current exchange rate is taken as the numerator.

In order to obtain the Real Effective Exchange Rate (*REER)*, the *NEER* is adjusted by the relative price indices of Kenya, and the weighted average price indices of Kenya's trading partners. In an equation form, this is expressed as:

$$REER_t = NEER_t \left[\frac{P_{wt}}{P_{dt}}\right] \quad (5),$$

where, P_{dt} is the price level in Kenya proxied by Consumer Price Index (CPI) at time *t*, and P_{wt} is the weighted average price level of Kenya's trading partner countries proxied by weighting CPI at time *t*. The price level of Kenya's trading partner countries is obtained by adding all the trade weighted price levels proxied by CPI of Kenya trading partners. This is shown in an equation form as follows:

$$P_{wt} = \sum_{it}^{n} P_{it} * w_t \quad (6),$$

where, P_{it}, is the price level of Kenya's i^{th} trading partner countries proxied by CPT at time *t*, w_{it} is the trade weight of Kenya's i^{th} trading partner country at time *t*. These weights are the same as those used in the derivation of *REER*.

Real Exchange Rate Volatility (V) - This study attempted to measure *RER* volatility in two ways. The first was through the computation of the (unconditional) standard deviations of *RER* changes within pre-determined periods while the second was through the Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) developed by Bollerslev in 1986. The standard deviation method is the most traditional way of measuring volatility (Kenen, and Rodrik, 1986, Caballero, and Corbo, 1989).Under this approach, the *RER* volatility is measured by computing the annual standard deviation of the *RER*. The monthly *RER* volatility also referred to as the growth rate of *RER* (V) is defined as the natural logarithm of the standard deviation of monthly *RERs* within a year, and is measured as follows:

$$V_i = ln\left[\sqrt{\frac{1}{n-1}\sum(RER_i - \overline{RER_\iota})}\right] \quad (7),$$

where, V_i denotes the *RER* volatility, RER_i represents the monthly *RER*, and $\overline{RER_\iota}$ denotes the 12-month average of *RERs*. The use of the standard deviation approach, however, has two weaknesses. The first weakness is that it assumes that the empirical distribution of *RER* is normal. The second limitation is that it ignores the distinction between predictable and unpredictable elements in the exchange rate process.

Due to the tendency for *RER* data to be skewed in terms of distributions or volatility clusters, the use of simple descriptive statistics such as the standard deviation method has been discouraged as a measure of *RER* volatility. Consequently other alternative models have been developed to measure *RER* volatility. One such model is, the Auto-Regressive Conditional Heteroscedasticity (ARCH), developed by Engle (1982). The model considers the variance of the current error term to be a function of the variances of the previous time period's error terms. In the context of this study, the model assumed that the *rer* uncertainty (volatility) was generated by first order autoregressive process that is specified as:

$$rer_t = \beta_0 + \beta_1 rer_{t-1} + \varepsilon_t \quad (8),$$

where rer_t is the natural logarithm of *rer*, β_0 and β_1 are the parameters to be estimated and ε_t is an error that is normally distributed with zero *(0)* mean, and constant variance (δ^2). The variance of the error term depends upon time *(t)*.

The ARCH model characterizes the way this dependence can be captured by an autoregressive process of the form:

$$\delta_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + \dots + \alpha_m\varepsilon_{t-m}^2 \quad (9),$$

where δ_t^2 is the conditional variance of the *rer*, ε_{t-1}^2 for *I = 1,2,3 .... m* denotes the squared residuals derived from equation 10, and α_1 for *I = 0, 1, ... m* are the parameters to be estimated.

The restriction $\alpha_1 \geq 0$ is meant to ensure that the predicted variance is always not a negative value. The term ε_{t-1}^2 represents the ARCH, and is therefore a measure of information about the *rer* volatility in the previous period. This study, however, employed the Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH). The GARCH model is an extension of the ARCH model in which the variance is given by:

$$\delta_t^2 = \alpha_0 + \beta_1\delta_{t-1}^2 + \beta_2\delta_{t-2}^2 + \cdots + \beta_k\varepsilon_{t-k}^2 + \alpha_1\delta_{t-1}^2 + \alpha_2\delta_{t-2}^2 + \cdots + \alpha_m\delta_{t-m}^2 \qquad (10),$$

where δ_{t-1}^2 for *j=1, 2... k* is the GARCH term representing the last period's forecast variance. GARCH *(1, 1)* is the simplest specification in this class, and is the most widely used specification. Thus, the GARCH (*1, 1*) model is given by:

$$\delta_t^2 = \alpha_0 + \beta_1\delta_{t-1}^2 + \alpha_1\varepsilon_{t-1}^2 \qquad (11).$$

This study employed equation 11 as the GARCH process to capture the *rer* volatility. This involves explaining the *rer* volatility by positing a structural relationship between volatility and its determinants

Data Source

The method of data collection was secondary research, which essentially involved reviewing data sources that have been collected for some other purpose than the study at hand. The main sources of the data was from local institutions were as follows: The Statistical Bulletins and the Monthly Economic Reviews of the Central Bank of Kenya (CBK): the Economic Surveys of the Kenya National Bureau of Statistics (KNBS), the Budget Outturns of the Ministry of Finance. For the study period of January 1993 to December 2009 with monthly frequency total of 204 data values were used.

In other instances, however, the data was extracted from the relevant publications or documents of the above institutions, and saved in Excel spreadsheet. The main sources of international data were the International Financial Statistics (IFS), and the Directorate of Trade Statistics (DTS). The Library Network that serves the World Bank Group, and the IMF, was the sole source of data from international sources. United Nations data base on social indicators was extensively reliable source of information.

EMPIRICAL RESULTS

This section measures and reports on the results of the *RER* volatility. In order to measure the *RER* volatility, the study generated GARCH specification as follows:

$$lnREER_t = \pi_t + \beta_t lnREER_{t-1} + \varepsilon_1 \qquad (12),$$

where $\varepsilon_t(O, h_t)$

$$\varepsilon_t = \alpha_t + \beta\varepsilon_{t-1}^2 + \gamma h_{t-1} + u_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

The above conditional variance of *RER* is a function of three terms (i) the mean,α, (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, ε_{t-1}^2 (the ARCH term), and (iii) the last period's forecast error variance, γh_{t-1} (the GARCH term) as shown in equation 13. This study estimated a number of versions of ARCH models. The GARCH (*1, 1*) model generated the best result shown in Table 3.1.

Table 3.1: GARCH Estimation of RER Volatility (Dependent Variable: LNRER)

Dependent Variable: RER
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 09/21/11 Time: 11:53
Sample: 1993M01 2009M12
Included observations: 204
Convergence achieved after 33 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	39172.50	90547.53	0.432618	0.6653
	Variance Equation			
C	3.35E+11	1.98E+10	16.89336	0.0000
RESID(-1)^2	0.818655	0.363499	2.252151	0.0243
GARCH(-1)	-0.046961	0.039906	-1.176791	0.2393
R-squared	0.057691	Mean dependent variance		211632.3
Adjusted R-squared	0.057691	S.D. dependent variance		719782.2
S.E. of regression	740253.6	Akaike info criterion		29.21426
Sum squared residual	1.11E+14	Schwarz criterion		29.27933
Log likelihood	-2975.855	Hannan-Quinn criteria.		29.24058
Durbin-Watson stat	0.562470			

Figure 1.2 below is displays the evaluation of the monthly RER volatility measure for the Kenya over the study period as generated by the GARCH approach.

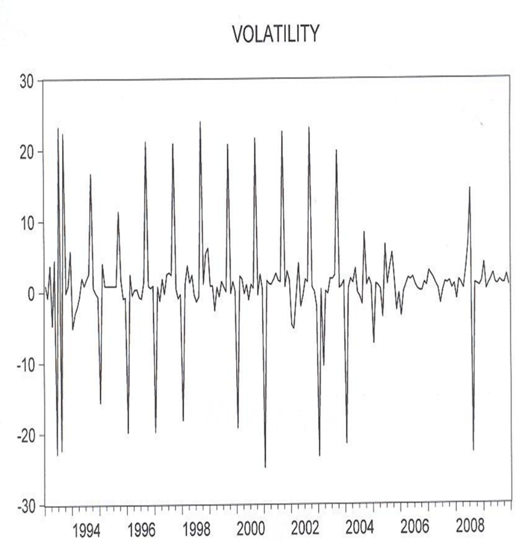

Figure 1.2 : GARCH Based RER Volatility

CONCLUSIONS AND DISCUSSIONS

The study adduced evidence that the conditional volatility of the *RER* depended on both domestic and external shocks to *RER* fundamental and macroeconomic changes. Overall, however, Kenya's *RER* generally exhibited a appreciating and volatility trend, implying that in general, the country's international competitiveness deteriorated over the study period.

Bini-Smaghi (1991) used Ordinary Least Square (OLS) technique to estimate the effect of *RER* volatility on trade in manufactured goods within the European Monetary System (EMS). The study found that *RER* volatility, measured by the standard deviation of weekly rates of changes of the intra-EMS effective rate for the quarter, had a negative, and significant effect on export volumes in all the three countries of (Germany, France, and Italy). The findings of Bini-Smaghi conquer with the current study findings.

Hondroyiannis *et al.*, (2005) undertook a study that examined the relationship between exchange-rate volatility, and aggregate export volumes for 12 industrial economies using a model that included real export earnings of oil-producing economies as a determinant of industrial-country export volumes. Five estimation techniques, including a generalized method of moments (GMM), and random coefficient (RC) estimation, were employed on panel data covering the estimation period 1977:1-2003:4 using three measures of volatility, namely, the absolute values of the quarterly percentage change in the exporting nation's effective exchange rate, log of the eight-quarter moving standard deviation of the *REER*, and a constructed GARCH measure of volatility. In contrast to current study, the study by Hondroyiannis *et al.*, (2005) did not find a single instance in which volatility had a negative, and significant impact on trade. In all cases, the coefficient on volatility was near zero.

Studies reviewed in this paper that used Johansen cointegration technique and found a negative and significant relationship between the *RER* volatility, and investment in developed countries are Caves (1989), Eun (1997), Dominquez and Tesar (2001), Bergin and Tchakarov (2003), Doukas et al., (2003),Kiyota and Urata (2004) and Siregar and Rajan (2004). These studies findings agree with the findings of the current study.

The study by Kiptoo (2007), focused on *RER* volatility and misalignment on international trade and investment. The study used Generalized Autoregressive Condition Heteroscedaticity (GARCH) and unconditional standard deviation. The study found out that RER volatility has a negative and significance impact on trade and investment during the study period 1993 to 2003. Finally, the study by Sifunjo (2011) examined chaos and non-linear dynamical approaches to predicting exchange rates in Kenya. The study used GARCH foreign rate volatility. The results suggest presence of non-linearity in the returns, high volatility in the market with a maximum duration of 6 months. Foreign exchange market was found not to be efficient in the weak form. The two study findings are similar o the current study findings on the high volatility of the real exchange rate in Kenya

REFERENCES

Arize, A.C. 1995. Trade Flows and Real Exchange Rate Volatility: An application of Cointegration and Error Correction Modeling, Journal of Economics & Finance, Vol. 6(1), pp. 37-51, JAI Press, Inc.

Bergin, P. and Tchakarov, I. 2003. Does Exchange Rate Risk Matter for ~welfare? A Quantitative Investigation, National Bureau of Economic Research (NBER) Working Paper Series, No. 9900. http://papers:nb'er.org/papers/w9900.pdf

Bollerslev, Tim 1986. Generalized Autoregressive Conditional Heteroscedasticity, Journal of Econometrics, Vol. 31, pp. 307-327.

Caballero, R. J.and. Corbo, V. 1989. The Effect of Real Exchange Uncertainty on Exports: Empirical Evidence, World Bank Economic Review, Vol. 3, pp. 263-278.

Caves, R.E 1989. Exchange Rate Movements and Foreign Direct Investment in the United States, in Audstretsch, D.B and Claudon, M.P (eds) The Internationalization of us Markets: 199-225.

Cheong, C. 2004. Does the Risk of Exchange Rate Fluctuations Really Flows Between Countries? Economics Bulletin, Vol. 1.6, pp. 1-8

Copeland, L. S. 1989. Exchange Rates and International Finance, University of Manchester Institute, United Kingdom pp. 41-75.

Cote, A. 1994. Exchange Rate Volatility and Trade: A Survey, Working Paper 94-5, Bank of Canada.

Dominquez, K.M.E., and Tesar, L.L. 200l. A Reexamination of Exchange Rate Exposure, NBER Working Paper Series, No. 8128, NBER, 1050 Massachusetts Avenue Cambridge, MA 02138: http://www.nber.org /Papers/w8453.

Dornbush, R. 1976. Expectations and Exchange Rate Dynamics, Journal of Political Economy, Vol. 84: 1161-1176.

Doukas, J.A, Hall P.H. and Lang L.H.P. 2003. Exchange Rate Exposure at the Firm and Industry, Financial Markets, Institutions and Instruments, New York University, Salomon Center, Published by Blackwell Publishing Inc., 350 Main St., Malden, MA 02148, US.

Eun C.S. 1997. International Equity Investments with Selective Hedging Strategies, Journal of International Financial Markets, Institutions and Money, Vol. 7, pp. 21-42.

Frenkel, J. A. and Goldstein, M. 1986. A Guide to Target Zones, NBER Working Paper Series, No. 2113.

Hondroyiannis, G., Swamy, P.A.V.B. and Ulan, M. 2005. Some Further Evidence on Exchange-Rate Volatility and Exports, Working Paper No. 28, Bank of Greece.

Kenen P. and D. Rodrik 1986. Measuring and Analyzing the Effects of Short-Term Volatility in Real Exchange Rates, The Review of Economics and Statistics, Vol. 68, pp.311-315.

Kikuchi, T. 2004. The Impact of Exchange Rate Volatility on Bilateral Exports in East AsianCountries, Graduate School of Systems and Information Engineering, University of Tsukuba, Thailand.

Kiptoo., C 2007. Real Exchange Rate Volatility, and misalignment in Kenya, 1993-2003 , Assessment of its impact on International Trade, and investments, unpublished Ph.D Thesis, University of Nairobi .

Kiyota, K. and Urata 2004. Exchange Rate, Exchange Rate Volatility and Foreign Direct Investment, Blackwell publishing Ltd 9600, Garsington Road, Oxford.

Lothian, J.R. and Taylor, M.P. 1997. Real Exchange Rate behaviour, Journal of International Money and Finance, Vol. 116, No. 6, pp.945-954.

McKinnon, R. ands Ohno, K. 1997. Dollar and Yen, MIT Press.

Pickard, J.C. (2003), Exchange rate Volatility and Bilateral Trade Floes, Ana Analysis of U.S. Demand for Certain steel Products From Canada and Mexico, Thesis Submitted to faculty of the Polytechnic Institute and State University impartial Fulfillment of the requirements for the Degree of Master of Arts in Economics.

Serven, L. 2002. Real Exchange Rate Uncertainty and Private Investment, Forthcoming Review of Economics and Statistics, The World Bank, Washington D.C., USA

Sifunjo, E. K 2011. Chaos and Non-linear Dynamical Approaches to Predicting Exchange Rates in Kenya,Unplished PhD Thesis Unviersity of Nairobi.

Siregar, R. and Rajan, R.S 2004. Impact of Exchange Rate Volatility on Indonesia's Trade Performance in the 1990s, Journal of the Japanese and International Economies, Vol. 18: 218-240.

Williamson, J. 1985. The Exchange Rate System, Institute for International Economics. Revised Edition, Washington, D.C.